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ABSTRACT

The acoustic features and functions of accentuation in French are discussed, and features of accentuation in the speech of French 2-year-olds are explored. The four major acoustic features used to signal accentual distinctions are fundamental frequency of voicing, duration of segments and syllables, intensity of segments and syllables, and frequency spectrum of segments. These phonetic features are used in different patterns by different languages. The speech of six 2-year-old monolingual French children was recorded and analyzed for variability and non-standard patterning in the use of intensity and accentuation. The data show the expected variability in use of acoustic phonetic features. The children appeared to be tending toward correct use of intensity and frequency of voicing patterns, but in fewer than 30 percent of their utterances did they produce a totally acceptable prosodic contour. Part of this variability in children's prosodic contours may be due to an inability to separate their respiratory and phonatory mechanisms in speech production or a universal perceptuo-motor tendency to produce words with a stress accent on the first syllable, a tendency in opposition to the normal pattern of French words. (RW)

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Intensity Accents in French 2 Year Olds' Speech

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By the term "accentuation" is commonly meant the distinguishing or highlighting of one or more words or syllables in a connected sequence of words or syllables. Among the common linguistic functions of accentuation are the marking of phonological phrase boundaries, the marking of word boundaries, and the signaling of contrastive meaning and/or emphasis. Often more than one of the functions of accentuation in a given language interact or overlap in complex ways. In the shouted English sentence I didn't say subject, I said SUBJECT! the strongly stressed second syllable of subject acts simultaneously in all four of the above mentioned functions. In other languages, however, the functions of accentuation are more restricted. French signals contrast and emphasis primarily[1] by the syntactic device of extraposition, using accentuation for lexical and phrase boundary marking purposes. The French accentual system also permits only word-final and phrase-final syllables to be accented. Thus there is in French no potential for "competition" between the lexical and phrase boundary marking functions as to which syllable in a word should be accented, as there often is in English.

The four major acoustic features used to signal accentual distinctions are 1) fundamental frequency of voicing (Fo), 2) duration of segments and syllables, 3) intensity of segments and syllables, and 4) frequency spectrum of segments (Lehiste, 1970). These acoustic features are associated more or less straightforwardly with features of speech production, speech perception, and phonological structure.

These phonetic features are used in different ways and in different combinations by different languages in the signaling of accentuation. Languages with so-called "tonic stress" (e.g., English and German) use all of these features, in various combinations, depending upon the circumstances. Accented syllables in English, for example, are typically marked by Fo movement, greater intensity, and spectra associated with strong allophones, but the additional association of greatly increased duration is often reserved for phrase-final position. French presents a different pattern. Accented syllables in phrase-medial position are marked only by an upward Fo glide, with little or no change in duration, intensity, or spectral strength,

1) The major exception to this rule is "accent d'insistence," a form of emphatic stress which also plays some demarcative role as well. See Séguinot (1976) for a full discussion of this complex feature of French prosody.

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whereas the last syllable of the phrase is produced with greater duration, lower Fo and slightly decreased intensity.

In the literature on phonological development, the suprasegmentals have received relatively little attention (cf. Crystal, 1979; Allen and Hawkins, 1980, for recent reviews). As a result, we have few data with which to constrain theories or test hypotheses. Especially lacking are cross-linguistic studies, from which we might determine the relative strengths of universal cognitive and psychomotor abilities vs specific features of the child's linguistic environment in shaping his or her suprasegmental phonology at different developmental stages. We thus know only in broad outline the strengths and weaknesses of young children in signaling prosodic distinctions.

Among the various suprasegmental features, only Fo seems to be well controlled by pre-linguistic children (Crystal, 1979). Intensity remains unstudied at this stage, though we know it is not used reliably by young speakers to signal accentuation (Hawkins and Allen, 1978). Speech rate is slow, making only the grossest distinctions of segment and syllable length (Naeser, 1970). Spectral variation is too wide to carry the strong/weak distinctions of syllable weight. It follows that the child will fall back on Fo wherever possible at first, gradually adding the other features as control over them develops.

Suppose the French child can hear the drop in intensity associated with the normal declarative phrase-final syllable. Then he may try to reproduce that intensity change, using any possible means. For example, he may devoice the syllable, thus reducing its intensity by 20 to 40 dB. Or, he may attempt to reduce his respiratory drive. Because the young child has poorly developed dynamic control of his respiratory musculature, the results of this effort would be highly variable, sometimes leading to appropriately small decrements in intensity, other times producing a devoiced syllable. Any of these patterns of acoustic marking would, however, be evidence that the child can hear a difference in intensity associated with the phrase final syllable.

Now suppose he cannot hear the intensity difference. In this case, the relative intensity of his phrase-final syllable will be controlled by 1) physiological linkages between intensity and any other associated features that he does control (e.g., Fo) and 2) not-yet-unlearned universal patterns of phrase rhythm. Recent studies of normal phonation have improved our understanding of the interrelationship between aerodynamic and neuromuscular activity at the level of the glottis (cf. Titze, 1980). According to present-day models, the effective stiffness of the vocal folds, and thus the resulting Fo, can be increased either by increasing neural input to the vocalis muscle or by increasing subglottal pressure. Because increased subglottal pressure also

results in increased intensity, this latter mechanism for controlling Fo results in a direct correlation between intensity and Fo, as is found in the so-called "unmarked intonation contours" of English. The slight decrease in Fo and intensity associated with French phrase-final syllables may in fact reflect this biomechanical constraint.

In addition to this biomechanical constraint on intensity, through its linkage to Fo, there may be a universal rhythmic constraint as well. Allen and Hawkins (1979) have proposed that, within rhythmic structures involving two or three syllables per foot, trochees and dactyls are somehow easier or more natural for young children than iambs and anapests, i.e., the accent should fall on the first syllable of the foot rather than the last. If this constraint in fact exists (Allen and Hawkins do not suggest any physiological or cognitive mechanism that might underlie it), then the young French child might be predisposed to place unwarranted emphasis on the initial syllables of his one-word phrases. Later experience would then presumably wean him away from that innate tendency.

We have, then, several reasons to suspect that the young French child's use of intensity may be highly variable or show non-standard patterning as an acoustic feature of accentuation. Let us now examine the speech of some French 2 year olds, to see if any of these possibilities are in evidence.

Six 2-year-old children of monolingual families were recorded in two nursery schools in Aix-en-Provence, France. Four were girls and two were boys, and their ages at the time of recording ranged from 21 to 32 months. The children were engaged in a picture-naming task by an assistant, who was a native speaker of the children's dialect. The children's utterances were recorded using a high-quality stereo cassette recorder and two microphones, one worn by the assistant, who was seated to one side of and facing the child, the other clipped to a pillow also near the child but on the side away from the assistant. The frequency response of the recording system was 50-13,500 Hz $\pm$ 3 dB. Background noise varied greatly in level, but utterances were elicited only during periods of relative quiet. The children were shown pictures of familiar things selected for their polysyllabic names (e.g., ballon, éléfant, télévision). Sometimes the child recognized the picture and named it freely; if the child did not seem to know the name, then the assistant attempted to elicit it. In all, 46 words were produced correctly by at least two of the six children. The tape recordings were then analyzed acoustically, using a Voiceprint model 700 speech spectrograph to produce average intensity traces (50 msec time constant) and 450 Hz wide band and 45 Hz narrow band spectrograms. The peak intensity was then measured ($\pm$ 1/2 dB) for the vocalic nucleus of each syllable.

It is difficult to summarize data as diverse as these. Different children, different pictures, different contexts, all lead to variability in the form of the names as they were produced. The items have therefore been grouped into gross categories of intensity and Fo contour (cf., Table I). A flat intensity contour is one in which the peak intensity of the word-final syllable was less than 2 dB different from the peak intensity of the preceding syllable. A narrow rise (fall) is one where the final syllable is between 2 and 5 dB greater (less) than the preceding syllable. For high rise (fall) the difference is greater than 5 dB.

	Intensity Contour					
Fo Contour	Wide Fall	Narrow Fall	Flat	Narrow Rise	Wide Rise	Total
Wide Fall	4	4	2	1	1	12
Narrow Fall	24	23	29	13	9	98
Rise-Fall	7	10	8	7	7	39
Flat	1	1	6	1	1	10
Fall-Rise	0	1	0	1	0	2
Narrow Rise	1	2	1	3	3	10
Wide Rise	0	1	0	2	7	10
Total	37	42	46	28	28	181

Table I - Number of intensity and Fo contours produced by French 2 year olds naming familiar pictures.

The Fo contours have been categorized perceptually. The names of the categories thus describe the pitch contours, as perceived. The words "narrow" and "wide" refer here to the perceived size of the pitch change within the contour and thus correspond directly to their use with the intensity contours.

First, observe the row of Table I corresponding to the narrow falling Fo contour. As may be seen there, 98 of the 181 contours, over 50%, fell into this category. Next, look at the two columns labeled "flat" and "narrow falling" intensity. Just under half (88 of 181) of the measured intensity contours fell into these two categories. These are the Fo and intensity contours that would be considered "normal" for naming responses. Therefore, the fact that such a large percentage of the children's utterances had one or the other of these two features correct suggests that the children were at least on the right track with their accentual contours. On the other hand, since only 52 contours, or fewer than 30%, had correct intensity and Fo, it seems that the children still have a ways to go.

As a check on the validity of these measurements, 40 utterances by the assistant who elicited the children's responses were

also measured. Each of the utterances was short (2 to 5 words) and contained one of the picture names in final position (e.g., Le pinceau. Très bien, c'est un crocodile.) Of these 40 utterances, 37 (92.5%) had "correct" accentuation, according to the model described above. The other 3 utterances had intensity decreases of -6, -7, and -8 dB, and there were no utterances with abnormally rising intensity on the last syllable. We may therefore conclude that these children were in fact more variable than adults in their use of intensity and Fo contours.

Two additional features of the data in Table I are of interest, in the light of the earlier discussion of how and why young French children might misuse intensity in their accentuated syllables. First, there is an overall positive correlation between intensity contour and Fo contour. The lower left and upper right cells of Table I are more sparsely populated than the main diagonal cells. Disregarding the "flat" intensity contours and the "rise-fall," "flat," and "fall-rise" Fo contours, for which a correlation between intensity and Fo would be relatively meaningless, the remaining falling and rising intensity and Fo contours can be grouped into a 2-by-2 table with a statistically significant positive relationship between the direction of movement of intensity and Fo ($X^2_{df=1} = 13.1$, $p < .01$). These data thus support the kind of positive correlation between intensity and Fo discussed earlier. This correlation is of the sort that might persist for some time in the French children's speech, since its cause is not under direct control of the speaker.

The other point of interest in these data is the preponderance of falling intensity contours (79 vs 56) and the relatively large number of wide falling intensities (37). These falling intensity contours suggest that perhaps there is still a trace of some "primitive" trochaic rhythm in these utterances. The data agree in this regard with those of Tilly, et al. (1981), who showed that young Swedish children control the trochaic accentual patterns in their language first, then later the iambic, but that control of these patterns appears to be complete by age 2 1/2 or 3 years. Thus, we may expect to find less of this tendency toward wide falling intensity contours in older French children's utterances.

We have come to expect young children to be variable in their use of acoustic phonetic features, and the data presented here are no exception. These children appear to have been tending toward the correct use of intensity and Fo patterns in their picture naming responses, but in fewer than 30% of their utterances did they produce a totally acceptable prosodic contour. We can now begin examining our older French children's utterances, to determine how and when this variability decreases to within adult norms.

Part of the variability in these children's prosodic contours appears to be due to an inability to "decouple" their respiratory and phonatory mechanisms in speech production. The "normal" declarative utterance-final contour in French involves a correlated slight decrease in intensity and Fo on the last syllable of the phrase. These children's utterances show a broader correlation, extending to large decreases and even large increases in these two suprasegmental features on the phrase-final syllable. It is also possible that some of the children's variability stems from a universal perceptuo-motor tendency toward producing words with stress-accent on their first syllable, a tendency in opposition to the normal pattern of French words. The large number of utterances (37 of 181) produced by these children with much greater intensity on their earlier syllable(s) suggests that this opposition has not yet been resolved by the age of 2 years.

In this presentation many squares on the accentual checkerboard have been cut across or even skipped entirely. I hope that, in spite of these shortcuts, the paper has suggested some of the many tantalizing questions that will lure us forward in our future research.

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